US007871701B2

(12) **United States Patent**
Mullen et al.

(10) **Patent No.: US 7,871,701 B2**
(45) **Date of Patent: Jan. 18, 2011**

(54) **CHIPBOARD**

(75) Inventors: **Robert L. Mullen**, Columbia, SC (US); **Antonius Kurniawan**, Huntsville, AL (US)

(73) Assignee: **Engineering Research Associates, Inc**, Huntsville, AL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/860,878**

(22) Filed: **Aug. 21, 2010**

(65) **Prior Publication Data**

US 2010/0316839 A1 Dec. 16, 2010

Related U.S. Application Data

(62) Division of application No. 12/102,050, filed on Apr. 14, 2008.

(51) **Int. Cl.**
B32B 5/16 (2006.01)

(52) **U.S. Cl.** **428/401**; 428/537.1

(58) **Field of Classification Search** 428/375, 428/401, 537.1, 292.4
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,986,782	A	12/1956	Elmendorf
3,164,511	A	1/1965	Elmendorf
3,202,743	A	8/1965	Elmendorf
3,563,844	A	2/1971	Brown
3,670,791	A	6/1972	Johnson
3,793,125	A	2/1974	Kunz
4,035,120	A	7/1977	Eriksson
4,058,201	A	11/1977	Etzold
4,096,796	A	6/1978	Saunders et al.
4,112,162	A	9/1978	Casselbrant
4,241,133	A	12/1980	Lund et al.
4,246,310	A	1/1981	Hunt et al.
4,339,478	A	7/1982	Greten et al.
4,610,913	A	9/1986	Barnes
4,751,131	A	6/1988	Barnes
5,002,713	A	3/1991	Palardy et al.
5,017,319	A	5/1991	Shen
RE34,283	E	6/1993	Barnes
5,274,899	A	1/1994	Sentagnes et al.
5,425,976	A	6/1995	Clarke et al.
5,435,054	A	7/1995	Tonder et al.
5,470,631	A	11/1995	Lindquist et al.
5,506,026	A	4/1996	Iwata et al.
5,539,027	A	7/1996	Deaner et al.

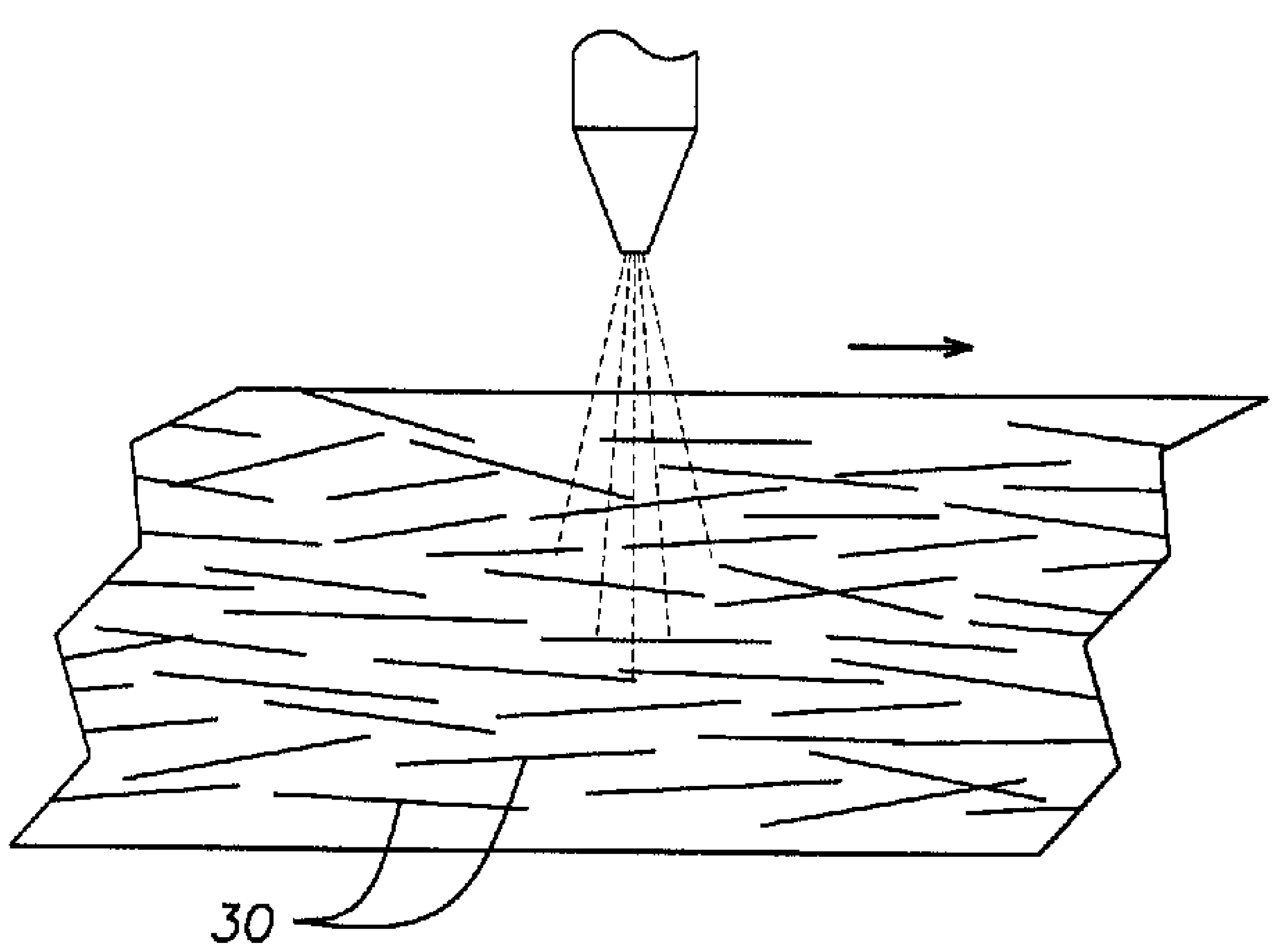
(Continued)

Primary Examiner—Alexander Thomas
(74) *Attorney, Agent, or Firm*—Pearne & Gordon LLP

(57) **ABSTRACT**

An oriented strand board for structural applications and a method of its production comprising elongated strands having aspect ratios greater than 2, the strands being derived from the outer shells of oil palm tree fronds formed as a bi-product of the harvest of oil palm fruit, such that the strand length is limited to about a meter, the strands being cut from the outer shell area of the fronds and at least the outer regions of the major faces of the board being substantially free of core material, the shell strands being combined with a heat settable binder material, the strands being formed by elongated blades moving relative to a frond length in planes generally aligned with a longitudinal direction of the frond length, the strands of the frond shells being arranged and being permanently bonded together such that they are predominately generally aligned with the structural direction of the board at least at the outer regions of the major faces of the board.

4 Claims, 4 Drawing Sheets



U.S. PATENT DOCUMENTS

5,554,429	A	9/1996	Iwata et al.
5,585,155	A	12/1996	Heikkila et al.
5,736,218	A	4/1998	Iwata et al.
5,988,537	A	11/1999	Marra
6,136,408	A	10/2000	Radcliffe et al.
6,383,652	B1	5/2002	Templeton et al.
6,390,161	B1	5/2002	Freitag et al.
6,451,153	B1	9/2002	Symons
6,461,472	B2	10/2002	Fujii
6,461,743	B1	10/2002	Tanzer et al.
6,479,127	B1	11/2002	Kornicer et al.
6,562,479	B1	5/2003	Smalley et al.
6,589,660	B1	7/2003	Templeton et al.
6,605,245	B1	8/2003	Dubelsten et al.
6,620,459	B2	9/2003	Colvin et al.
6,641,909	B1	11/2003	Wasylciw
6,756,105	B1	6/2004	Haataja
6,761,798	B2	7/2004	Altheimer et al.
6,767,490	B2	7/2004	Sean et al.
6,800,352	B1	10/2004	Hejna et al.
6,818,317	B2	11/2004	Hejna et al.
6,830,784	B2	12/2004	Gutowski et al.
6,830,797	B2	12/2004	Haataja
6,846,553	B2	1/2005	Haataja et al.
6,916,523	B2	7/2005	Haataja
6,926,785	B2	8/2005	Tanzer et al.
2003/0026942	A1	2/2003	Hejna et al.
2003/0035921	A1	2/2003	Kornicer et al.
2003/0124305	A1	7/2003	Haataja
2003/0180506	A1	9/2003	Haataja
2004/0003984	A1	1/2004	Bossler
2004/0063891	A1	4/2004	Colvin et al.
2004/0229010	A1	11/2004	Clark et al.
2005/0037202	A1	2/2005	Hejna et al.
2005/0126726	A1	6/2005	Altheimer
2005/0142328	A1	6/2005	Haataja
2005/0171313	A1	8/2005	Colvin et al.

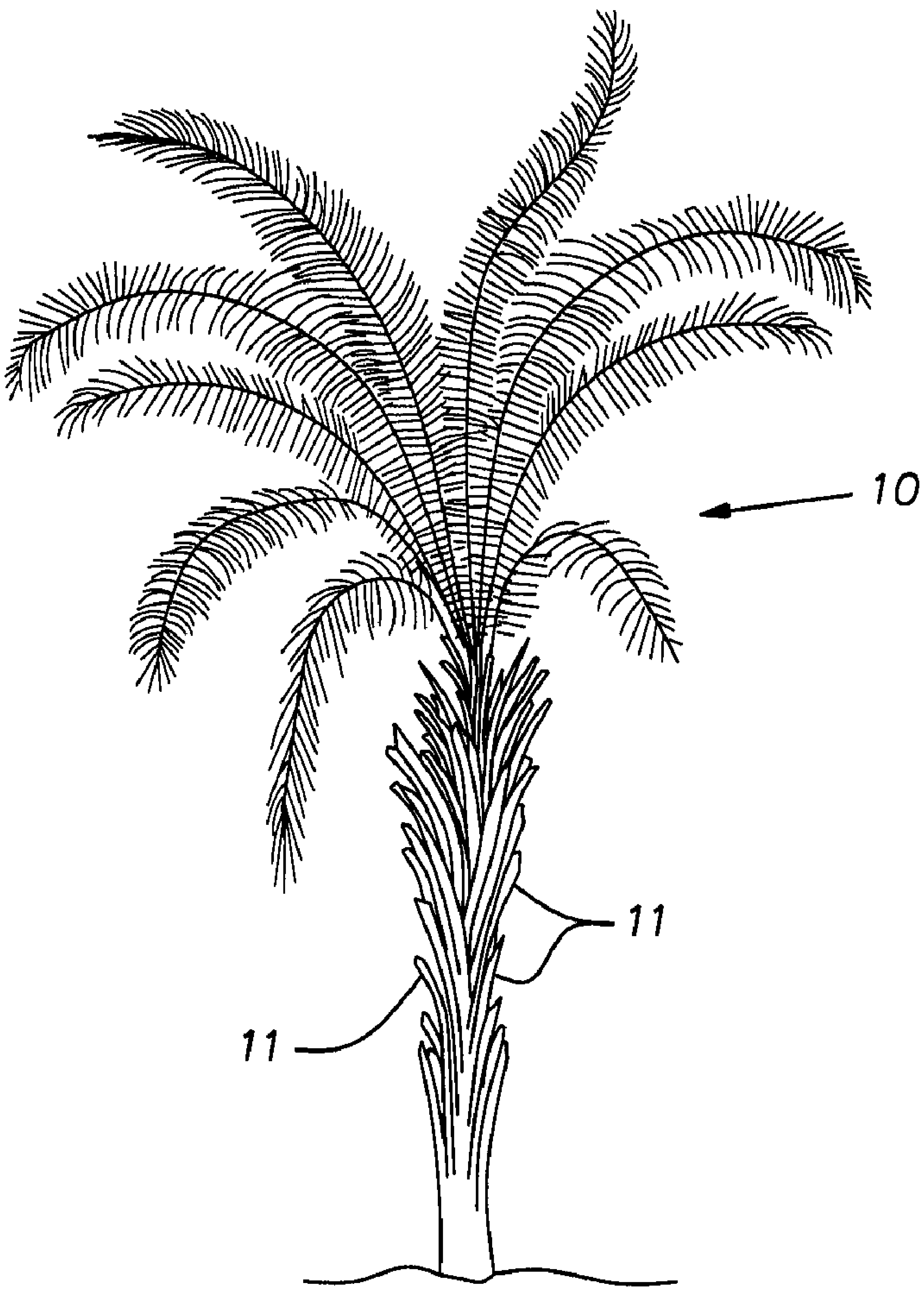


FIG. 1

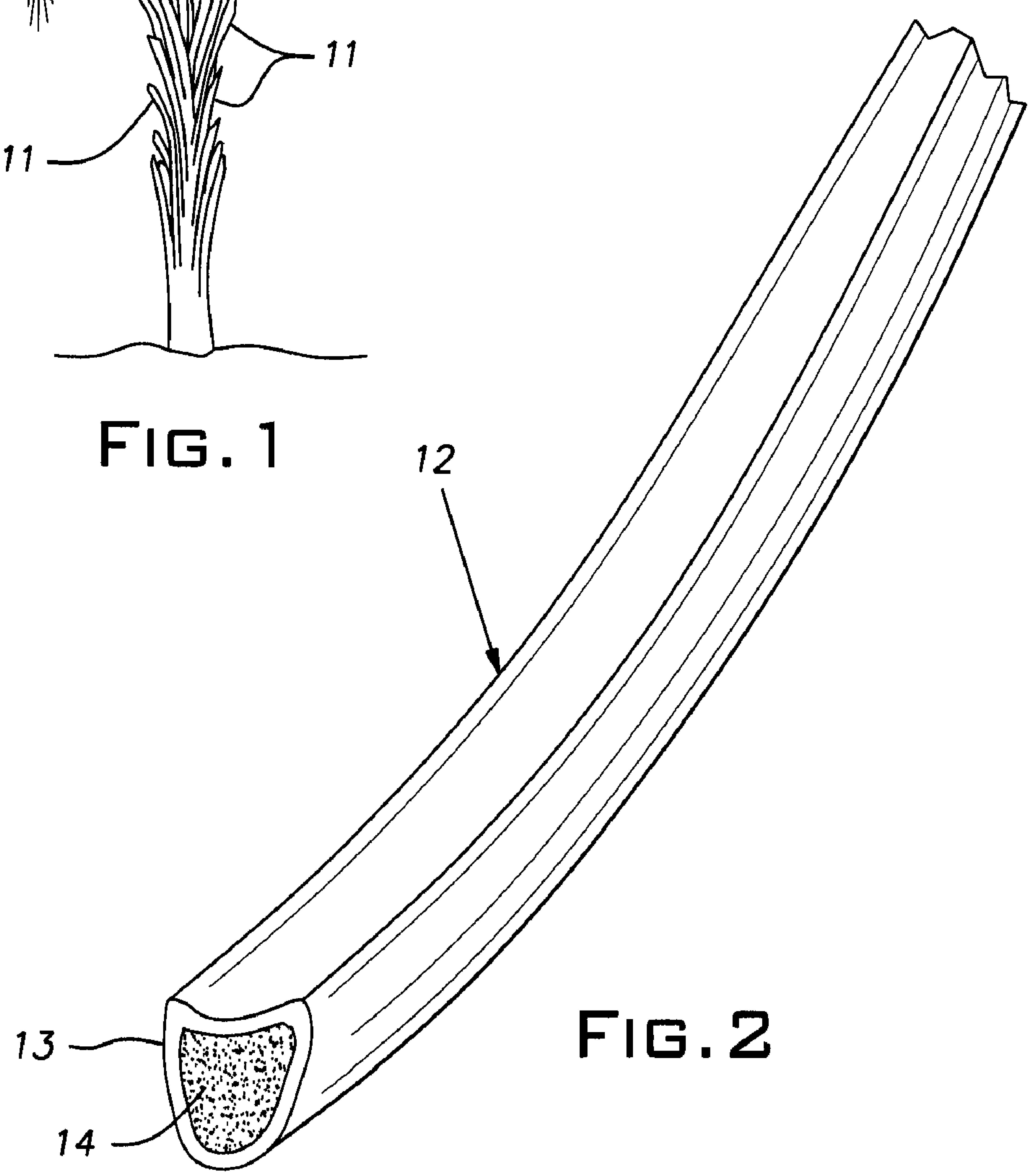
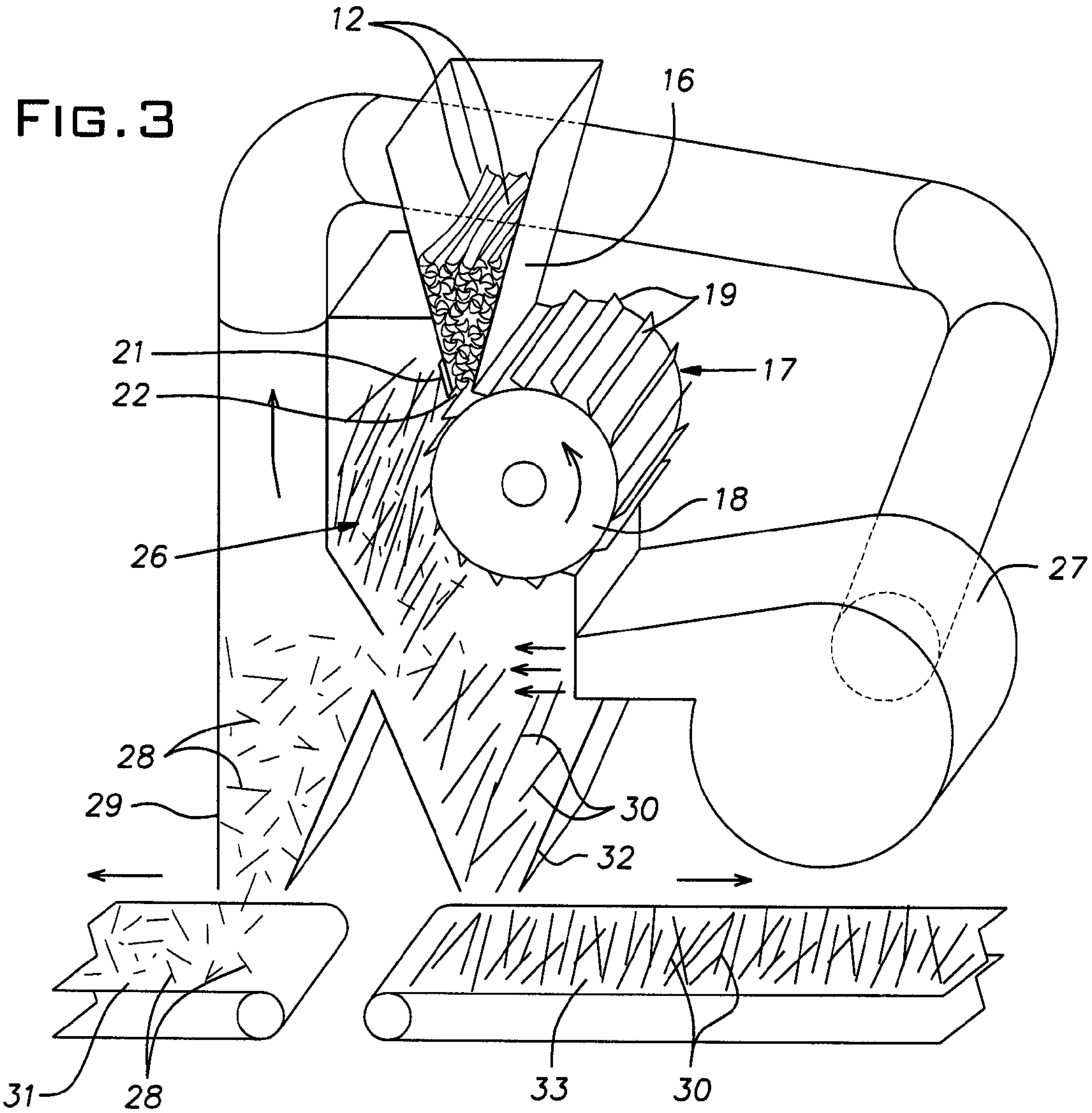


FIG. 2

FIG. 3



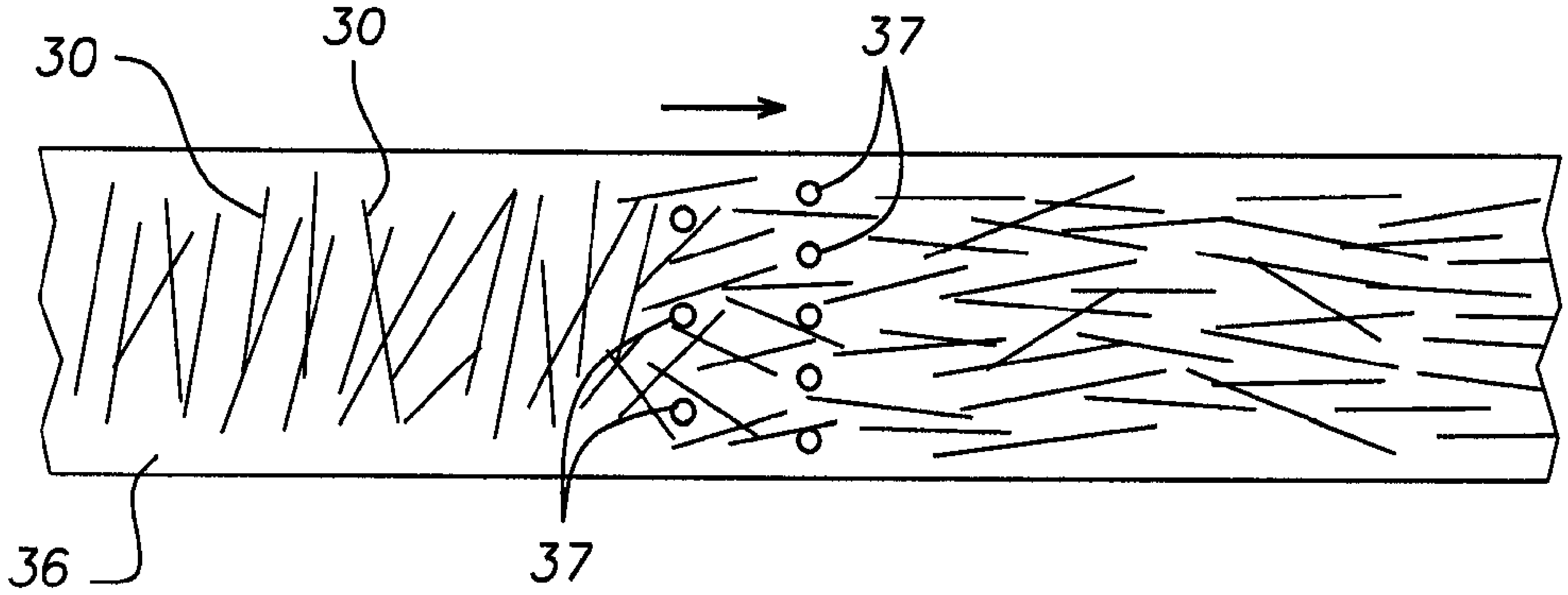


FIG. 4

FIG. 5

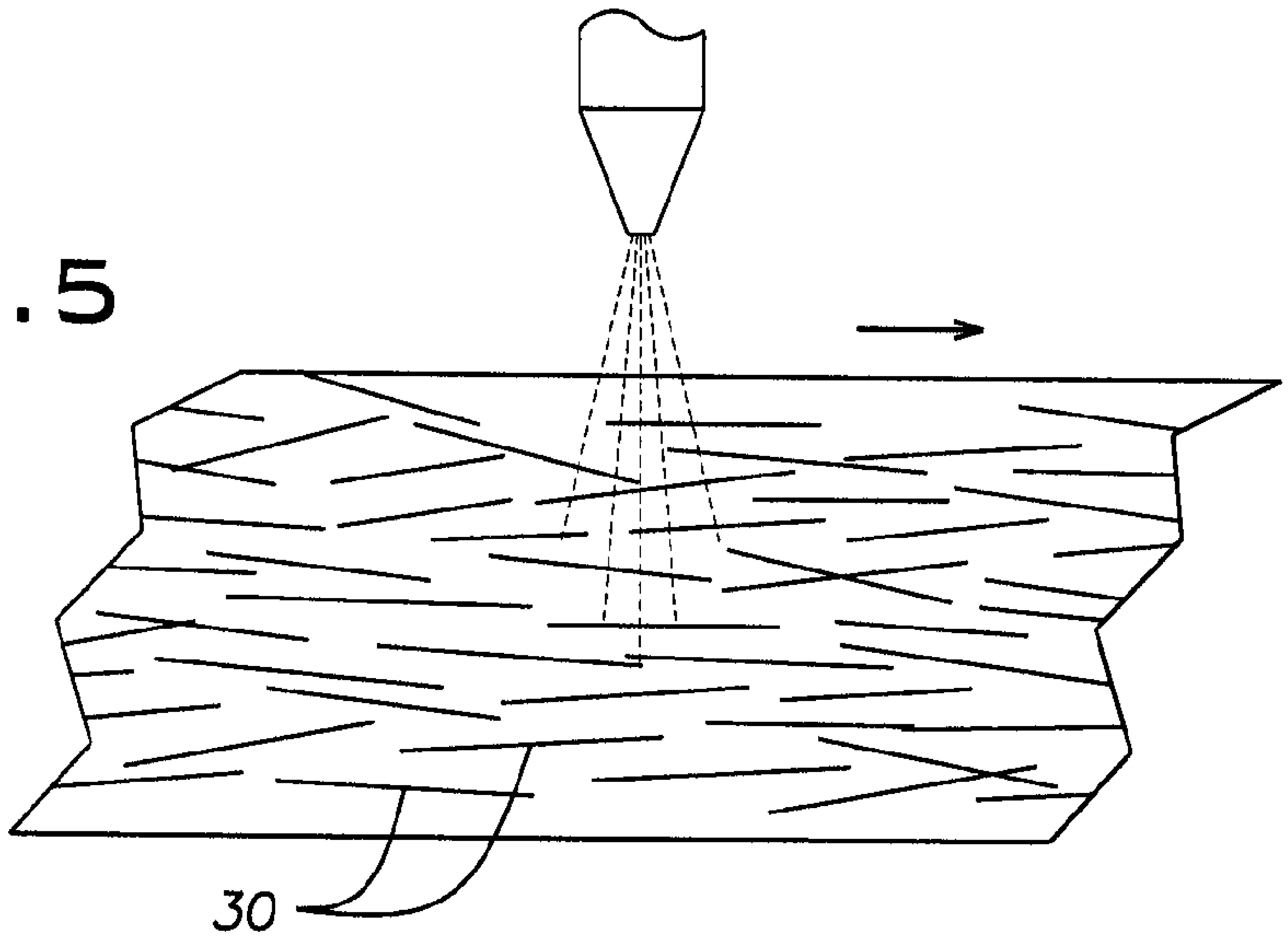
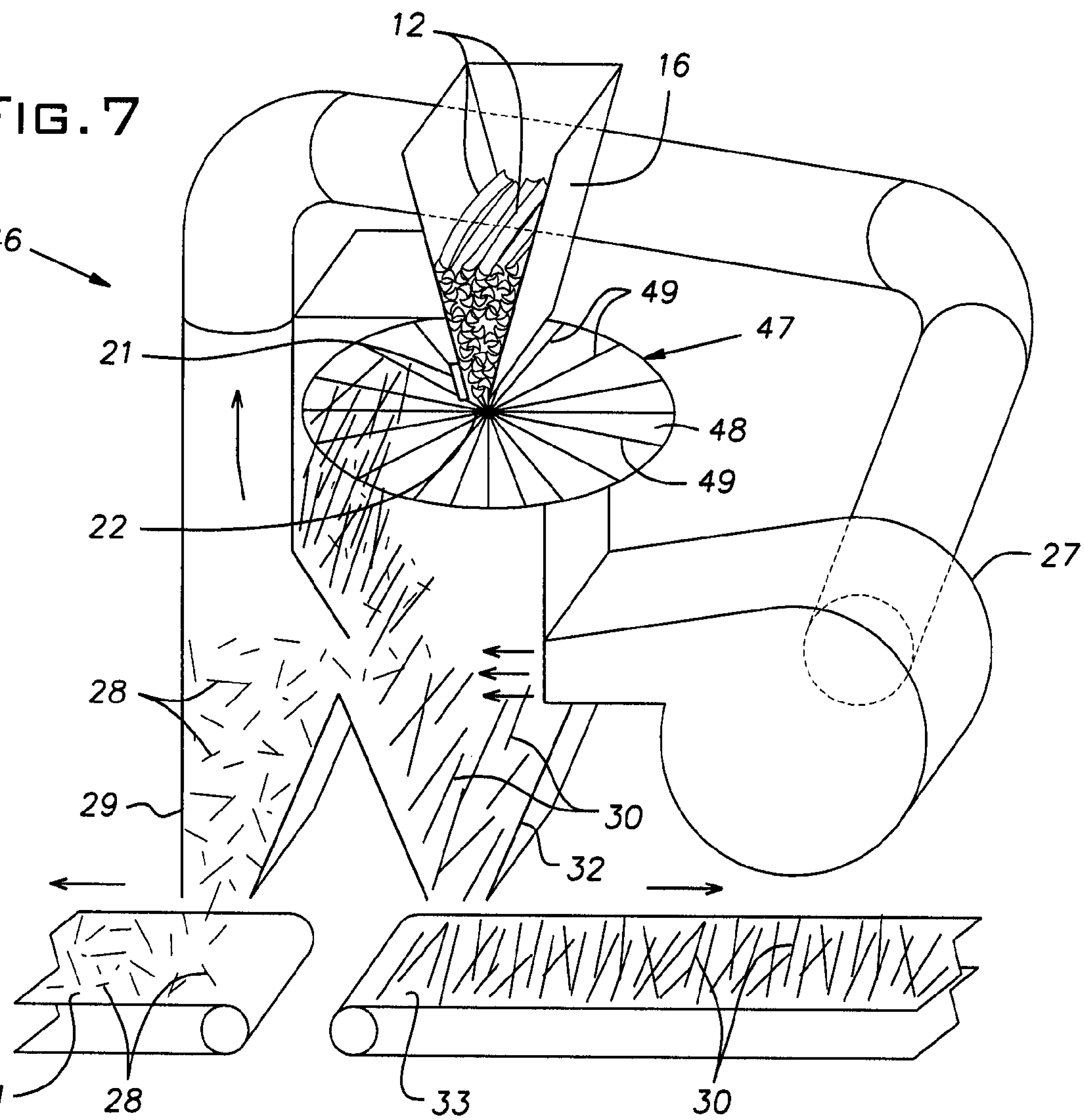


FIG. 7



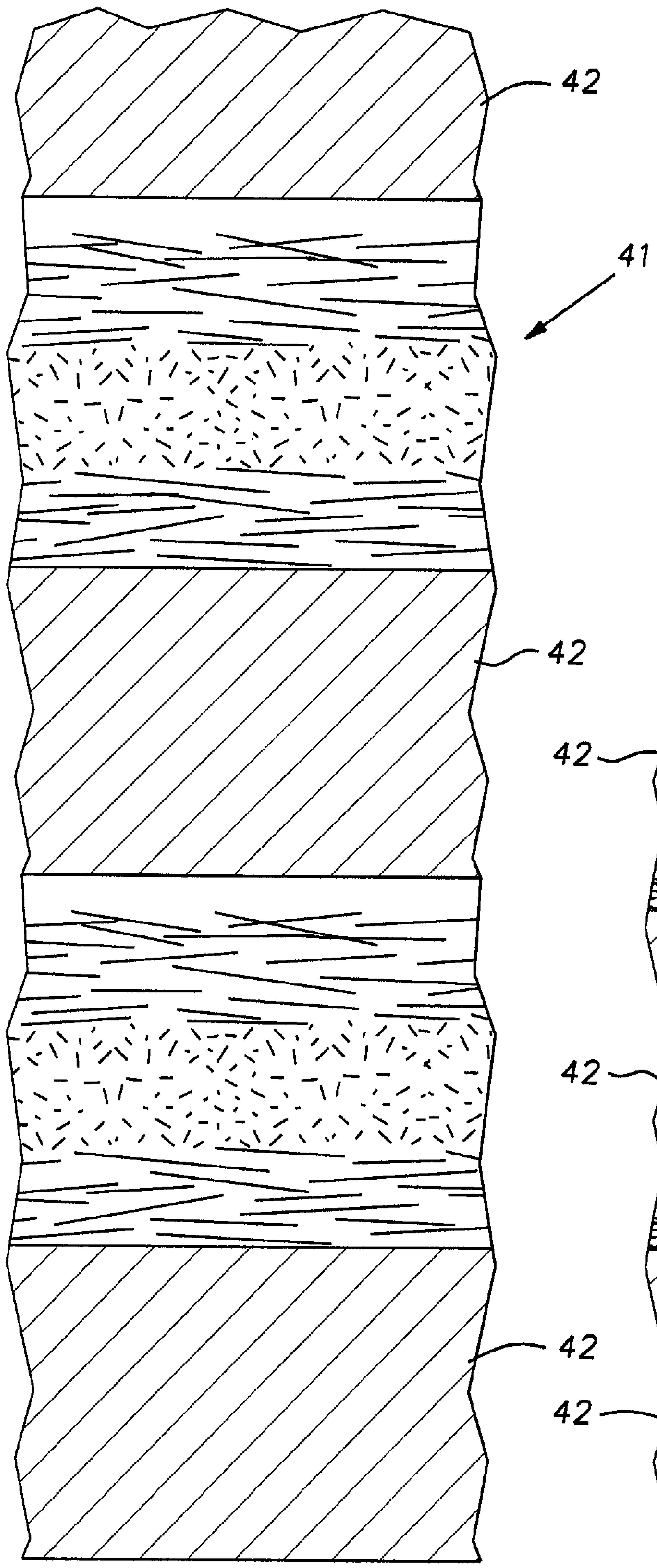


FIG.6A

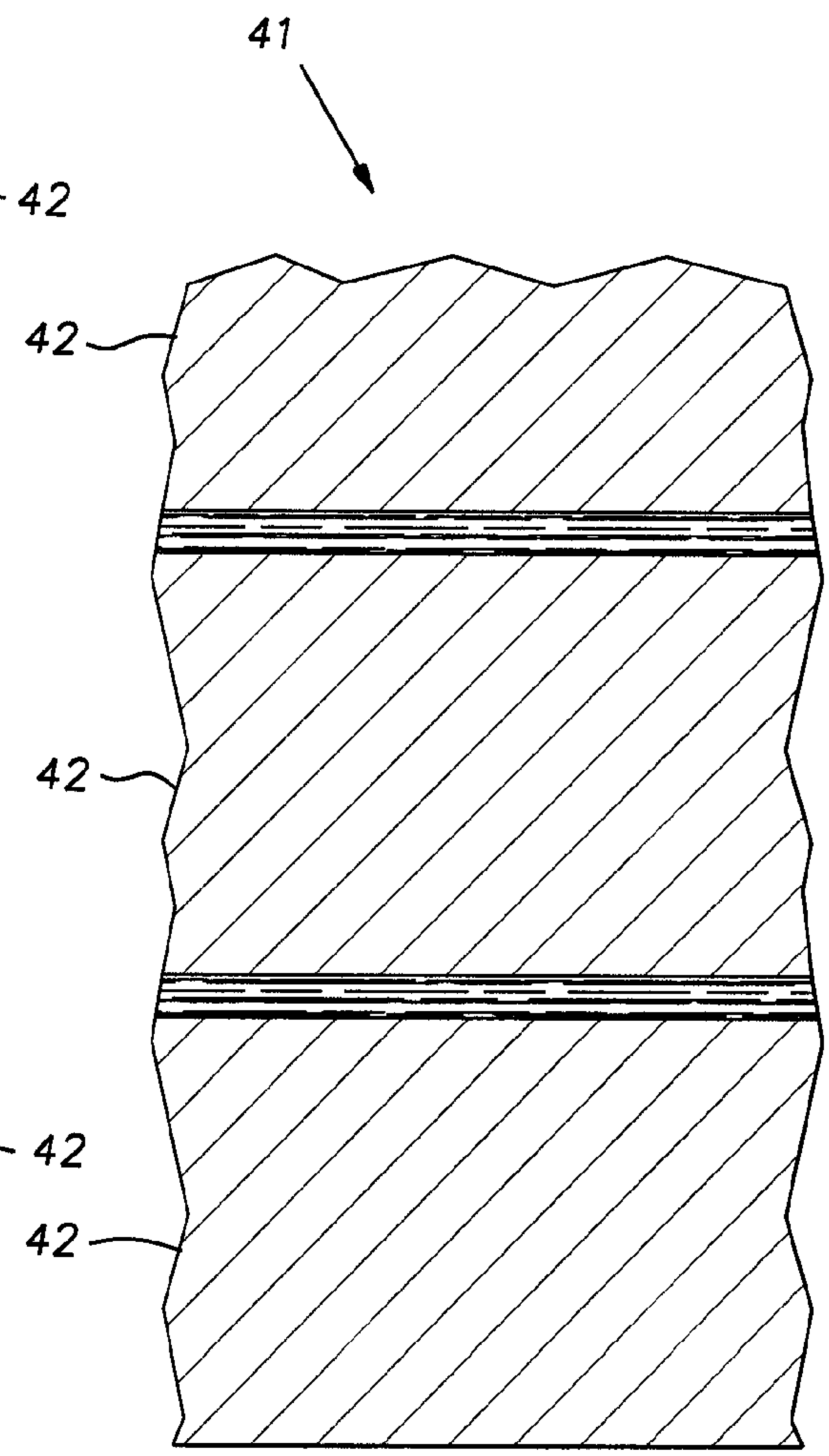


FIG.6B

CHIPBOARD

This application is a divisional of Ser. No. 12/102,050 filed Apr. 14, 2008, pending.

BACKGROUND OF THE INVENTION

The invention pertains to the manufacture of structural boards and, in particular, to a process and product utilizing a unique and plentiful source of raw material.

PRIOR ART

Oriented strand board (OSB) is a product used largely in the construction industry in place of plywood. Ordinarily, OSB sells for a price less than that of plywood. The economics are generally explained by the cost of raw material used to make these products. OSB is typically made from tree limbs sometimes called "round stock" that are too small in diameter and/or length to form lumber or plywood veneer. Supplies of round stock are limited both in volume and geography so that some price floor for this commodity necessarily exists. There remains, then, a need for a substitute material that can be at least competitive in price and availability with round wood for use in the manufacture of structural boards.

SUMMARY OF THE INVENTION

The invention provides a novel OSB construction that utilizes selected parts of oil palm tree frond cuttings as its raw material or base stock. This raw material is plentiful, low in cost, and, presently, can be a liability to growers and is largely going to waste. Frond cuttings are generated when oil palm fruit is harvested. Fronds are cut away to gain access to the fruit they naturally envelope. Currently, this harvesting is done manually, and the length of the frond cuttings is somewhat variable, but for reference purposes, may be roughly in the order of 1 to 2 meters with a woody section of a half meter with a cross-section of a frond roughly between 1/20 to 1/10 of a meter wide.

It has been discovered that a relatively high tensile strength shell part of an oil palm frond, when properly dried and separated from a low density frond core, such that it is in a strand-like form, can be processed into boards of commercial quality and strength.

The preferred strand forming process has the advantage of obtaining a relatively high yield of stranded shell material free or nearly free of the core material. As disclosed, the frond cut length or section is subjected to a planning operation in which cutting blades slice the frond length along lines that are generally parallel to the nominal length direction of the frond. This blade movement leaves the shell material in strand-like pieces that are severed away from the core. The core material is machine separated from the shell stock preferably by capitalizing on differences in density and fragment size of these two components. Typically, the cutting action is vigorous enough to knock loose large pieces of core material from the shell strands to which they may be attached that may have simultaneously sheared off with the shell material from the parent part of the frond cutting. In the disclosed board making process, the machined shell and core materials are separated from one another by impingement of an air stream directed

against a flow of these mixed materials. The machine formed shell strands are thereafter generally aligned and coated with a binder and conveyed to a press. Typically, the binder is a thermoset resin. The press subjects the aligned and binder coated shell strands to heat and pressure sufficient to set the binder and produce a dense solid board.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a drawing of an oil palm tree that has had lengths of its lower fronds cut away during previous harvests of its fruit;

FIG. **2** is a perspective view of a length of the woody root section of a frond cut from an oil palm tree;

FIG. **3** is a diagrammatic isometric view of an exemplary system for forming strands of the shell of a frond length and separating these strands from core material originally encased within the shell;

FIG. **4** is a diagrammatic fragmentary representation of a process step in which the frond shell strands are generally oriented into a common direction;

FIG. **5** is a diagrammatic fragmentary representation of a process step in which the frond shell strands are coated with a binding agent and conveyed into a multi-platen press;

FIG. **6**A is a diagrammatic representation of a charging step of a strand mat into a press;

FIG. **6**B is a diagrammatic representation of a pressing and heating step in the process of making OSB; and

FIG. **7** is a diagrammatic representation of an alternative arrangement for a strand making apparatus with the plane of movement of the cutting blades aligned with the longitudinal direction of a frond length.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** is a drawing of an oil palm tree **10** originally indigenous to Africa and now commercially grown in various equatorial territories. The fruit of the oil palm is harvested for its oil frequently on a very large scale for food and chemical applications. To pick the fruit, a worker, typically using a machete, hacks off the fronds enveloping it from below. The truncated fronds **11**, on the lower part of the tree shown in FIG. **1**, are the result of this practice. A cut length **12** of a frond is illustrated in FIG. **2**. On average, the frond section produced during a fruit harvest can have a woody length of about 2 or 3 feet, i.e. about ½ meter, although this length can obviously vary considerably.

The frond section or length **12** will characteristically have a modest bow or large radius of curvature and will typically be V-shaped in cross-section. Moreover, the frond length **12** has a relative hard and dense shell indicated generally at **13** associated with its exterior surfaces and a relatively soft core **14**. When the frond section **12** is dry, the shell **13** is considerably harder than pine wood and the core **14** is nearly as soft as balsa wood. The volume of the core **14** substantially exceeds that of the shell **13**.

In accordance with the invention, the frond section or length **12** can be processed to generate strands from the shell **13** and to separate the core material **14** from this stranded shell material.

FIG. **3** illustrates an example of a system to cut frond sections or lengths **12** into longitudinally oriented strands. Frond sections **12** are fed to a chute **16** or other device that presents the frond sections with a common orientation so that their lengths are more or less parallel, their slightly bowed character preventing full orientation.

At the lower end of the chute **16** is a rotary knife unit **17**. The knife unit **17**, power driven by a motor, not shown, has a cylindrical rotor **18** with a plurality of circumferentially spaced blades or knives **19** mounted in parallel alignment with the rotational axis of the rotor **18**. The rotary knife unit **17** is oriented so that its axis of rotation is parallel to the preferred alignment of the frond sections **12** as determined by the lengthwise direction of the rectangular discharge area of chute **16**. The blades **19** intercept and cut the frond sections **12** on lines parallel to their nominal longitudinal direction, first shearing off elongated strands of the shell **13** and, ultimately, shredding the core **14** into pieces. A gap between a restraining bar **21** at a side of the chute **16** where the blades **19** retire from the discharge area of the chute and the rise of the blades from an outer surface **22** of the rotor **18** is proportioned to assure that a frond section **12** will be cut into pieces of limited desired thickness.

The predominant lengths of strands **26** of the frond section **12** will be less than the full length of a frond section **12** owing to the natural bow of the section along its length and the straight character of the cutting edges of the blades **19**. The strands **26**, in general, will have aspect ratios of at least 2.

All of the material of the frond sections **12** being sheared by the rotary cutter **17** falls by gravity away from the cutting area at the bottom of the chute **16**. A fan or blower **27** directs a strong air current transversely through a path of the falling shredded frond material. The velocity and volume of the air current is regulated to separate the strands designated **30** of the shell **13** from the shredded core material designated **28**. This air separation works on the difference in bulk density between the relatively dense shell material **13** and relatively less dense core material **28**. The core material **28** is deflected by the air stream to a chute **29** that directs it to a conveyor **31** which carries it to a collection point (not shown). The stranded shell material **30**, owing to its greater density than that of the core material **28**, is deflected by the air stream to a lesser extent and, consequently, falls into a chute **32** that directs it to a conveyor **33**.

The stranded shell material **30**, carried off by the conveyor **33** is ultimately processed into oriented strand board (OSB).

FIGS. **4** through **7** illustrate steps performed to accomplish this transformation. FIG. **4** illustrates a conveyor **36** that receives randomly oriented oil palm frond strands **30** made from the shells **13** of cut length sections **12** of fronds by a process such as described and shown in FIG. **3**. The strands **30** are more or less oriented in the direction of travel of the conveyor **36** by instrumentalities such as alignment fingers or gates **37** overlying the conveyor and that require elongated strands to generally orient themselves to the conveyor direction before they can pass the fingers or gates.

After being oriented, the shell strands **30** are coated for example, by spraying, with a binder as depicted in FIG. **5**. Alternatively, the binder can be in a powder or pellet form and be uniformly distributed with the strands before, while, or after the strands are oriented. The binder can be that used with common structural wood-based OSB such as a phenolic resin or an isocyanate powder. The oriented, binder coated shell strands **30** are conveyed to a press **41** such as a multi deck press known in the art where numerous platens **42** are arranged one above the other.

The shell strands **30** conveyed to the press **41** are laying loosely on one another in a non-compacted state with a controlled thickness that can be received in the space between retracted platens as shown in FIG. **6**A. If desired, the material forming the uncompacted mat can comprise sublayers with different orientations of the strands **26**. These sublayers can be constructed upstream of the press **41**. Ordinarily, the outer sublayers, i.e. the top and bottom sublayers will have an orientation of the strands **30** aligned with the ultimate panel or board's strength axis typically aligned with the longest dimension of a rectangular board. The internal sublayers can be cross-oriented to this structural direction. Moreover, the internal sublayers can contain a higher proportion of core material from the fronds **11** as compared to the outer layers where the separation of the core material from the shell strands **30** is maintained at a greater level so that these outer sublayers are comprised substantially of all stranded material from the frond shell **13**.

The platens **42** are internally heated to an elevated temperature sufficient to cure the binder while the shell strands **30** remain under pressure. The mats of shell strands **30**, as depicted in FIG. **6**B, remain under pressure and temperature for a time sufficient to cure the binder and produce a rigid structural board from the compacted, binder impregnated mat of frond strands **30**. The mats and platens can be of relatively large area representing the area of several finished structural boards. Finished structural boards can be, for example, ¼" to 1" thick and 4' by 8' in planar dimensions or metric equivalents when cut from these oversize mats.

FIG. **7** illustrates an alternative device **46** and method of cutting frond sections **12** into strands oriented generally along their longitudinal direction. Elements that are the same or equivalent to those of FIG. **3** are identified with the same numerals. The device **46** comprises a circular rotor plate **47** that rotates about its central axis. On an upper face **48** of the plate **47** are mounted a plurality of bar-like knives **49**. The knives **49** are oriented radially with respect to the center of rotation of the plate **47**. The knives **49** pass under the chute **16** in which frond sections **12** are guided in a queue in parallel alignment. The blades or knives **49** move in a plane parallel to the nominal longitudinal axis of the general frond sections **12** and when passing across the outlet of the chute **16** cut lengthwise strands from the frond sections. The frond section strands **30**, **28** of the shell and core material can be separated by an airstream in generally the same manner as described in connection with FIG. **3** or by other techniques. The strands **30**, **28** of the shell of the frond sections are used as described hereinabove to produce structural panels or OSB.

It should be evident that this disclosure is by way of example and that various changes may be made by adding, modifying or eliminating details without departing from the fair scope of the teaching contained in this disclosure. For example, OSB boards can be produced in a single platen press or in a continuous processing line using a series of pressing rollers. The invention is therefore not limited to particular details of this disclosure except to the extent that the following claims are necessarily so limited.

What is claimed is:

1. An oriented strand board for structural applications comprising elongated strands having aspect ratios greater than 2, the strands being derived from the outer shells of oil palm tree frond lengths formed as a bi-product of the harvest of oil palm fruit, such that the strand length is limited to about a meter, the strands being cut from the outer shell area of the fronds and at least in the outer regions of the major faces of the board being substantially free of frond core material, the strands of the frond length shells being arranged and being permanently bonded together such that they are predominately aligned with the structural direction of the panel at least at the outer regions of the major faces of the board.

2. An oriented strand board as set forth in claim 1, wherein the board has major dimensions of about 4' by 8' and a thickness of about ¼" to 1" or metric equivalents.

3. An oriented strand board as set forth in claim 1, wherein the frond shell strands are cuttings of frond lengths produced by blades moving in directions that cut the fronds generally lengthwise.

4. An oriented strand board as set forth in claim 1, wherein the shell strands are bound together by a heat settable binder material.

* * * * *